

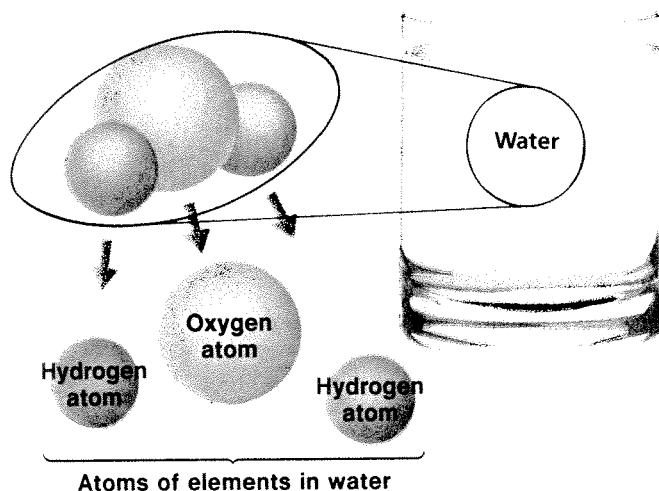
14-1 What are atoms?

Objectives ▶ Identify an atom as the smallest part of an element. ▶ List the parts of Dalton's atomic theory.

TechTerm

- ▶ **atom:** smallest part of an element that can be identified as that element

Atoms An **atom** is the smallest part of an element that can be identified as that element. Elements are simple substances that cannot be broken down into simpler substances. What happens if you keep cutting an element into smaller and smaller pieces? There is a smallest piece of an element that cannot be divided any further. This smallest piece is called an atom.

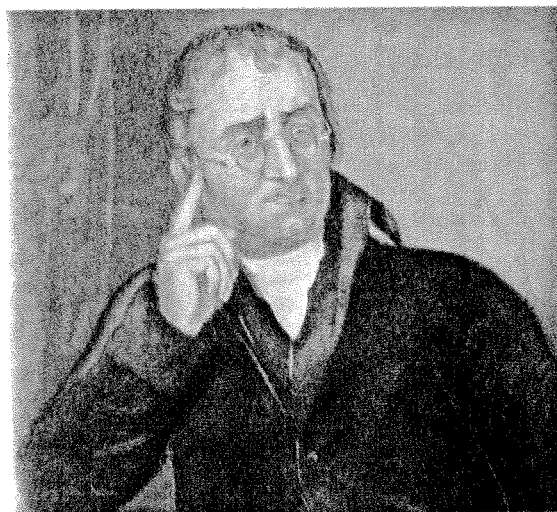


▶ **Define:** What is an atom?

Democritus The first person to suggest the idea of atoms was the Greek philosopher Democritus (di-MAHK-ruh-tus). More than 2400 years ago, Democritus asked whether it is possible to divide a sample of matter forever into smaller and smaller pieces. After much thought, Democritus came to the conclusion that it is not possible to divide matter forever. At some point, a smallest piece would be reached. Democritus named this smallest piece an atom. The word "atom" comes from a Greek word that means "cannot be divided."

Democritus and his students did not know what scientists today know about atoms. However, they hypothesized that atoms were small, hard particles that were all made out of the same material. They also thought that atoms were infinite in number, that they were always moving, and that they could be joined together.

▶ **Identify:** What does the word "atom" mean?



Dalton's Atomic Theory In the early 1800s, an English chemist named John Dalton did some experiments. Based on his observations, Dalton stated an atomic theory of matter. The main parts of Dalton's atomic theory are as follows:

- ▶ All elements are composed of atoms. Atoms cannot be divided or destroyed.
- ▶ Atoms of the same element are exactly alike.
- ▶ Atoms of different elements are different.
- ▶ The atoms of two or more elements can join together to form compounds.

Like Democritus, Dalton had some ideas about atoms that scientists no longer agree with. However, Dalton's atomic theory was the beginning of the modern theory of atoms.

▶ **List:** What are the parts of Dalton's atomic theory?

12-5

What are elements?

Objective ► Identify elements as simple substances that cannot be broken down.

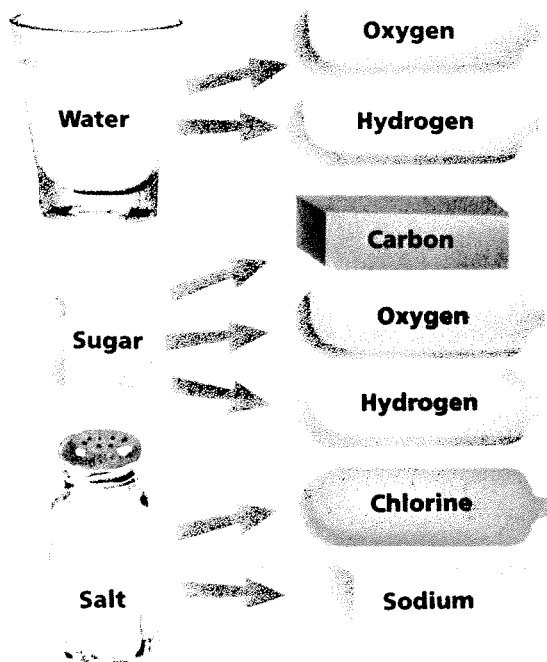
TechTerm

- **elements** (EL-uh-munts): simple substances that cannot be broken down into simpler substances

Elements Some substances can be broken down into other substances. Water can be broken down into hydrogen and oxygen. Sugar can be broken down into carbon, hydrogen, and oxygen. Salt can be broken down into sodium and chlorine. However, hydrogen, oxygen, carbon, sodium, and chlorine cannot be broken down. All of these substances are **elements** (EL-uh-munts). An element is a simple substance that cannot be broken down into simpler substances.

► **Define:** What is an element?

The Known Elements There are 109 known elements. Ninety-two elements are found in nature. The other 17 elements have been made by scientists under special laboratory conditions. Most elements are solids at room temperature.



Some common examples of solid elements are iron, tin, lead, silver, gold, calcium, and copper. A few elements, such as mercury and bromine, are liquids. Other elements, such as oxygen, hydrogen, and nitrogen, are gases.

► **Identify:** How many elements are found in nature?

Elements and Matter All matter is made up of elements. Some types of matter are made up of only one element. An iron nail contains only the element iron. Aluminum foil is made up of only the element aluminum. Gold and silver are other familiar substances that are made up of only one element.



Other substances are made up of more than one element. Water is made up of hydrogen and oxygen. Table salt is made up of sodium and chlorine. Sugar is made up of carbon, oxygen, and hydrogen. Brass is made up of copper and zinc. In the laboratory, a chemist can break down a substance such as sugar into the elements that make it up.

► **Name:** What three elements make up sugar?

What is a compound?

Objective ► Recognize that compounds can be broken down into simpler substances.

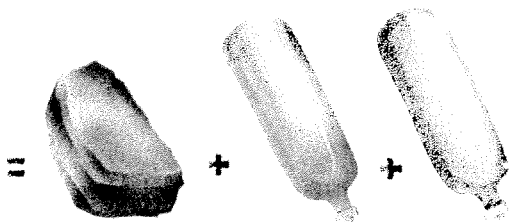
TechTerm

- **compound:** substance made up of two or more elements chemically combined

Combining Elements Hydrogen and oxygen are elements. They are both gases at room temperature. These two elements can combine to form a liquid. When hydrogen combines chemically with oxygen, water is formed. Water is a **compound**. A compound is a substance made up of two or more elements that are chemically combined.

►►► **Define:** What is a compound?

Compounds Most of the matter making up the earth is composed of compounds. Sugar is another compound. It is made up of the elements carbon, hydrogen, and oxygen. Table salt is a compound. It is made of the elements sodium and chlorine.



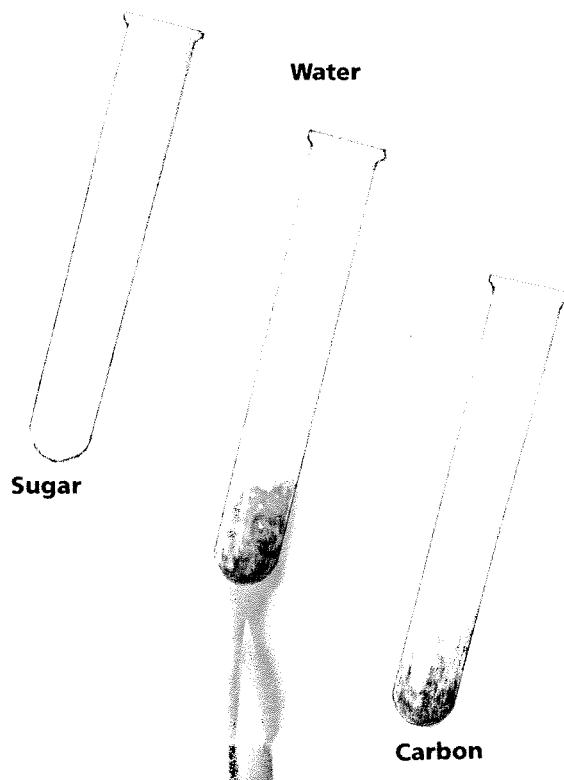
Sugar = Carbon + Hydrogen + Oxygen

►►► **Name:** What are three examples of common compounds?

Properties of Compounds The properties of a compound are very different from the properties of the elements that make it up. Sodium is a metal that burns very easily. Chlorine is a poisonous gas. Sodium and chlorine combine to form the compound sodium chloride, or table salt. Sodium chloride is neither a metal nor a poisonous gas. Salt is a white solid. It has its own properties.

►►► **Contrast:** How do the properties of salt differ from the properties of sodium and chlorine?

Forming Compounds A compound is formed as a result of a chemical change. A chemical change causes elements to lose their original properties. The elements combine to form a new substance with different properties. A chemical change can also cause a compound to break down into the elements that make it up. When sugar is heated, it melts into a liquid. If the liquid is heated long enough, water composed of hydrogen and oxygen is released into the air. Finally, only a black solid remains. This solid is the element carbon. Heating the sugar caused it to break down into the elements that formed it.



►►► **Describe:** How can a compound be broken down into the elements that formed it?

What are molecules?

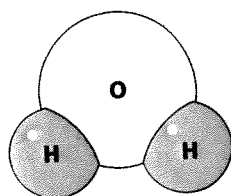
Objective ▶ Identify a molecule as the smallest part of any substance.

TechTerm

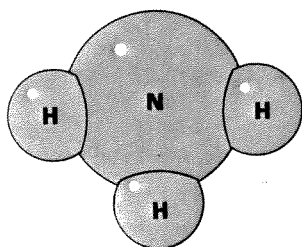
- ▶ **molecule:** smallest part of a substance that has all the properties of the substance
- ▶ **substance:** any element or compound

Parts of Substances Matter is composed of different kinds of **substances**, either elements or compounds. Sugar is a substance. A single grain can be broken down into millions of smaller **molecules**. A molecule is the smallest part of a substance that has all the properties of the substance. A molecule of sugar is the smallest part of sugar that has the properties of sugar. Molecules can be composed of two or more atoms.

▶▶▶ **Define:** What is a molecule?



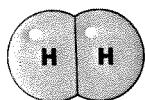
Water molecule



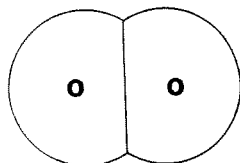
Ammonia molecule

Diatomic Molecules Molecules of some elements contain pairs of atoms and are called diatomic (dy-uh-TAHM-ik) molecules. A diatomic molecule has two atoms of the same element joined together. An oxygen molecule has two oxygen atoms joined together. Hydrogen is also diatomic. In fact, most gaseous elements form diatomic molecules.

▶▶▶ **Identify:** How many atoms are there in a molecule of hydrogen?

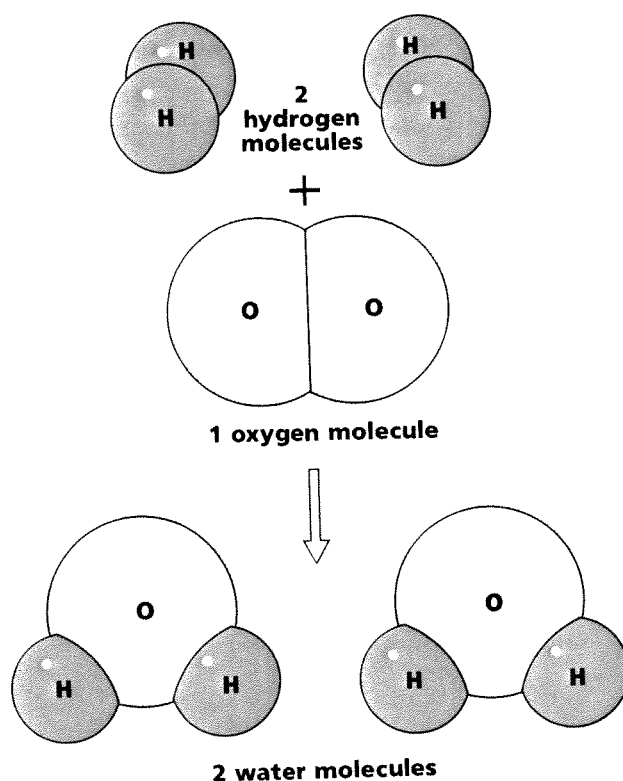


Hydrogen molecule



Oxygen molecule

Combining Atoms Water is a compound made up of the elements hydrogen and oxygen. One molecule of water contains two atoms of hydrogen and one atom of oxygen. Any molecule of water contains the same kinds of atoms joined together. Whether the water exists as a solid, a liquid, or a gas, one molecule of water always contains two atoms of hydrogen joined to one atom of oxygen.



Different types of molecules are made up of different combinations of atoms. The compound salt contains the elements sodium and chlorine. A molecule of salt is made up of one atom of sodium joined with one atom of chlorine. The elements carbon, hydrogen, and oxygen are found in the compound sugar. A molecule of sugar contains 12 atoms of carbon, 22 atoms of hydrogen, and 11 atoms of oxygen. Every sugar molecule always contains the same combination of atoms.

▶▶▶ **Identify:** What is one molecule of water made of?